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CLAIMS

[Claim(s)]

[Claim 1] The light emitting device which carries out outgoing radiation of the transmitting light of the 1st wavelength, and the spectral separation filter which penetrates the transmitting light by which outgoing radiation is carried out from said light emitting device. The lens which condenses the light which penetrated said spectral separation filter by the end face by which the slanting cut of the optical fiber was carried out. It has the photo detector which receives the receiving light of the 2nd wavelength which outgoing radiation was carried out from the end face of said optical fiber, and was collimated by said lens. It sets to the optical transceiver module with which it is reflected by said spectral separation filter, and said receiving light results in said photo detector through opening of a diameter phi, and is $\phi <= 0.3f$ (however, f focal distance of said lens) about the diameter phi of said opening.

It is $d = f - \sin \theta$ (however, theta outgoing radiation angle from the optical fiber of said receiving light) about the core of said opening to the straight line given at right angles to said opening through the intersection of the medial axis of said lens, and said spectral separation filter while it was alike and setting up.

The optical transceiver module characterized by carrying out **** eccentricity.

[Claim 2] The optical transceiver module characterized by setting the diameter phi of said opening as $0.2 f < \phi <= 0.3f$ in the publication of claim 1.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the optical transceiver module for combining a light emitting device and a photo detector to the optical fiber with which two or more transmitting light and receiving light of different wavelength are transmitted.

[0002]

[Description of the Prior Art] the sectional view of the optical transceiver module of the former [drawing 4] — it is — this drawing — ** — like, the case of this optical transceiver module is divided roughly, and is constituted by four blocks, the central block 1, the LD (laser diode) block 2, the PD (photodiode) block 3, and the fiber block 4, and the spectral separation filter 5 is attached in the central block 1. LD6 which is a light emitting device, and the lens holder 8 which supports a lens 7 are attached in the LD block 2, PD9 which is a photo detector, and the lens holder 11 which supports a lens 10 are attached in the PD block 3, and the optical fiber 12 and the lens holder 14 which supports a lens 13 are attached in the fiber block 4.

[0003] After being made parallel with the lens 7 by the side of the LD block 2, the transmitting light of the wavelength lambda 1 by which outgoing radiation was carried out from LD6 penetrates the spectral separation filter 5 within the central block 1, and subsequently it is condensed with the lens 13 by the side of the fiber block 4, it carries out incidence to the end face of an optical fiber 12, and it is transmitted through an optical fiber 12. On the other hand, after diffusing the receiving light of the wavelength lambda 2 transmitted through the optical fiber 12 in the end face of an optical fiber 12, it is made parallel with the lens 13 by the side of the fiber block 4, subsequently is reflected by the spectral separation filter 5 within the central block 1, and, subsequently is condensed with the lens 10 by the side of the PD block 3, and it is received by PD9.

[0004]

[Problem(s) to be Solved by the Invention] By the way, in the conventional optical transceiver module mentioned above, in order to prevent that the transmitting light of the wavelength lambda 1 by which outgoing radiation was carried out from LD6 reflects by the apical surface of an optical fiber 12, and returns to LD6, the apical surface of an optical fiber 12 is aslant cut at an angle of predetermined.

[0005] However, as the broken line of drawing 4 showed, after a part of transmitting light of the wavelength lambda 1 reflected by the end face by which the slanting cut of the optical fiber 12 was carried out is reflected by the spectral separation filter 5 through the lens 13 by the side of the fiber block 4, incidence may be carried out to the light-receiving side of PD9 through the lens 10 by the side of the PD block 3, and, in such a case, there was a problem that the S/N ratio of an input signal got worse.

[0006]

[Means for Solving the Problem] Suppose this invention that opening which can restrict the light to penetrate is prepared into the optical path to which it is reflected with a spectral separation filter, and the receiving light by which outgoing radiation was carried out from the end face of an optical fiber results in a photo detector. Although the receiving light of the 2nd wavelength by which outgoing radiation was carried out from the end face of an optical fiber can carry out incidence to the light-receiving side of a photo detector through opening if such opening is prepared. Since this transmitting light does not reach the light-receiving side of a photo detector through opening even if it is reflected with a spectral separation filter after a part of transmitting light of the 1st wavelength by which outgoing radiation was carried out from the light emitting device reflects by the end face of an optical fiber, The transmitting light which reaches a photo detector can be reduced and the S/N ratio of an input signal can be raised.

[0007]

[Embodiment of the Invention] The light emitting device which carries out outgoing radiation of the transmitting light of the 1st wavelength by the optical transceiver module of this invention, The spectral separation filter which penetrates the transmitting light by which outgoing radiation is carried out from said light emitting device, and the lens which condenses the light which penetrated said spectral separation filter by the end face by which the slanting cut of the optical fiber was carried out, It has the photo detector which receives the receiving light of the 2nd wavelength which outgoing radiation was carried out from the end face of said optical fiber, and was collimated by said lens. While said receiving light sets the diameter phi of said opening as $\phi \leq 0.3f$ (however, f focal distance of said lens) in the optical transceiver module which is reflected by said spectral separation filter and results in said photo detector through opening of a diameter phi. Only $d=f \sin \theta$ (however, theta outgoing radiation angle from the optical fiber of said receiving light) carried out eccentricity of the core of said opening to the straight line given at right angles to said opening through the intersection of the medial axis of said lens, and said spectral separation filter.

[0008] Moreover, in consideration of aggravation of the incidence effectiveness from said optical fiber, the minimum of the diameter phi of said opening was set as the range of $0.2f \leq \phi \leq 0.3f$.

[0009]

[Example] If an example is explained with reference to a drawing, the sectional view of the optical transceiver module which drawing 1 requires for one example of this invention, the sectional view of the case block with which this optical transceiver module is equipped with drawing 2, and drawing 3 are the explanatory views showing the important section of this optical transceiver module, and the same reference mark is given to the configuration member corresponding to drawing 4.

[0010] As shown in drawing 1 and drawing 2, the optical transceiver module concerning this example has one case block 20, and LD6 explained in the conventional example to this case block 20, the lens holder 8 which supports a lens 7, the spectral separation filter 5, the lens holder 14 which supports the lens 13 by the side of a transmission line, and the optical fiber 12 with which the slanting cut of the apical surface was carried out are attached in the same axle. Moreover, the reflective mirror 15 for light-receiving, the lens holder 11 which supports a lens 10, and PD9 are attached in this optical axis and parallel to the case block 20 at the same axle. In addition, the spectral separation filter which can reflect the light of wavelength lambda 2 may be used instead of the reflective mirror 15.

[0011] As shown in drawing 2 in detail, the opening 21 for arranging a lens holder 8, the opening 22 for arranging the body section of LD6, the attaching hole 23 for attaching the flange of LD6, and the opening 24 for optical paths are continuously formed in the case block 20. Inner base 23a of an attaching hole 23 is the datum clamp face of LD6, and LD6 is welded to the case block 20, where the flange is compared to inner base 23a of an attaching hole 23. Thereby, the whole flange fits into the interior of an attaching hole 23, and only the lead section exposes LD6 from the side face 31 of the case block 20. Moreover, the clamp face 25 for attaching the spectral separation filter 5 45 degrees aslant to an optical axis at openings 21, 22, and 24 and the same axle by the side of this luminescence, the opening 26 for arranging a lens holder 14, and the opening 27 for optical paths are formed in the case block 20, and an optical fiber 12 is attached in the side face 28 of the case block 20. Moreover, the opening 29 for arranging a lens holder 11, the opening 30 for arranging the body section of PD9, and the clamp face 32 for attaching the reflective mirror 15 45 degrees aslant to an optical axis are formed in the case block 20 in parallel with the openings 21, 22, and 24 by the side of luminescence. Furthermore, the opening 35 which opens both the clamp faces 25 and 32 for free passage is formed in the case block 20, and this opening 35 lies at right angles to it to each of the openings 21, 22, and 24 by the side of luminescence, and the openings 29 and 30 by the side of light-receiving. The side face 31 of the case block 20 is the datum clamp face of PD9, and PD9 is welded to the case block 20, where the flange is compared on a side face 31. By this, PD9 will be attached in the case block 20 so that a flange and the lead section may be exposed from a side face 31, and LD6 will be attached inside from PD9 by the flange of PD9 to the case block 20.

[0012] The front perpendicular to the clamp face 25 of the spectral separation filter 5 and the clamp face 32 of the reflective mirror 15 is opened wide greatly, respectively, and the notches 25a and 32a corresponding to these open parts are formed in the case block 20. These notches 25a and 32a are covered with the covering 40 of a pair put on the case block 20. In addition, the bis-hole 33 and the engagement slot 34 are formed in the case block 20, and the bis-hole 33 is a hole for insertion of the screw (not shown) for fixing an optical transceiver module to a chassis, a printed circuit board, etc. of

electronic equipment, and it is for preventing that an optical transceiver module rotates the engagement slot 34 at the time of a bis-stop.

[0013] In the optical transceiver module constituted like the above, after being made parallel with a lens 7, the spectral separation filter 5 is penetrated, it is condensed with a lens 13, and incidence of the transmitting light of the wavelength lambda 1 by which outgoing radiation was carried out from LD6 is carried out to the end face of an optical fiber 12, and it is transmitted through an optical fiber 12. On the other hand, after diffusing the receiving light of the wavelength lambda 2 transmitted through the optical fiber 12 in the end face of an optical fiber 12, it is made parallel with a lens 13, is reflected by the spectral separation filter 5, subsequently it is reflected by the reflective mirror 15, and is condensed with a lens 10, and it is received by PD9. Although the transmitting light of the wavelength lambda 1 by which outgoing radiation was carried out from LD6 penetrates the spectral separation filter 5 here and it is condensed with a lens 13 In order to return to the spectral separation filter 5 through a lens 13 after the part reflects by the end face of an optical fiber 12 as the broken line of drawing 3 shows, This transmitting light carries out incidence to the light-receiving side of PD9, and it is made to have not generated a cross talk by specifying the formation location and magnitude of said opening 35.

[0014] That is, as shown in drawing 3 in detail, when it sets the medial axis of a lens 13, and the intersection of the spectral separation filter 5 to O and the straight line given at right angles to said opening 35 through this intersection O is set to L, the core of opening 35 is $d=f-\sin \theta$ to a straight line L..... It is formed in the location which carried out eccentricity only of the **. In this ** type, if the refractive index of the core of thetaF and an optical fiber 12 is set to n for the include angle of the apical surface by which f is the focal distance of a lens 13, and the outgoing radiation angle of the receiving light to which outgoing radiation of theta is carried out from the end face of an optical fiber 12, and was cut across the optical fiber 12, the outgoing radiation angle theta will be given by degree type **.

$\text{Theta}=\sin^{-1}(n-\sin \theta_F)-\theta_F$ When ** and the size of opening 35 are examined, NA (numerical aperture) from which intensity distribution are Gaussian distribution mostly, and, as for the outgoing radiation light from SMF (single mode fiber), reinforcement is set to 1 / e2 is about 0.08, and the intensity distribution I over include-angle thetaF of the outgoing radiation light from an optical fiber 12 are expressed with degree type **.

$I=e^{-0.095 \theta_F}$ The quantity of light P contained in ** include-angle thetaF is $P=1-e^{-0.095 \theta_F}$ Since it is **, theta in case the quantity of light P becomes 99.9% (100% infinity sake) from this ** type is called for as $\theta_F=8.627$ degrees, and since it is $NA=\sin \theta$, it is set to $NA=0.15$. That is, for a lens 13, when about 100% of light will enter by $NA=0.15$ and the diameter of opening 35 is set to phi, since it is $\phi=2\pi NA f$, the upper limit of the diameter phi of opening 35 is $\phi=0.3f$ It becomes **. On the other hand, about the minimum of the diameter phi of opening 35, since aggravation of the incidence effectiveness from SMF which does not become a problem practically was decided to be 95%, from the above-mentioned ** type, theta in case the quantity of light P becomes 95% is called for as $\theta_F=5.74$ degrees, and is set to $NA=0.1$ from $NA=\sin \theta$. That is, in order for 95% of light to enter, they are 0.2 $f < \phi < 0.3f$ about the minimum of the diameter phi of opening 35..... It is necessary to make it ** and is 0.2 $f < \phi < 0.3f$ about the diameter phi of opening 35 from these **s and ** type.... It turns out that what is necessary is just to set it as the range of **.

[0015] Therefore, by making the eccentricity only of the amount d of gaps which the diameter phi of opening 35 is set as the magnitude with which are satisfied of the above-mentioned ** type, and is asked for the core of opening 35 by the above-mentioned ** formula from a straight line L carry out in the direction which keeps away from an optical fiber 12 Even if it returns to the spectral separation filter 5 after a part of transmitting light of the wavelength lambda 1 by which outgoing radiation was carried out from LD6 reflects by the end face of an optical fiber 12 As the broken line of drawing 3 shows, this return light being interrupted around opening 35, after reflecting with the spectral separation filter 5, and the transmitting light of wavelength lambda 1 carrying out incidence to the light-receiving side of PD9, and generating the receiving light and the cross talk of wavelength lambda 2 is lost.

[0016] In addition, although the above-mentioned example explained the case where LD6 and PD9 had been arranged on the same side face 31 of the case block 20, it is also possible to omit the reflective mirror 15 and to arrange the lens holder 11 which supports a lens 10, and PD9 on other side faces (lower limit side of drawing 1) of the case block 20 which intersects perpendicularly with a side face 31.

[0017]

[Effect of the Invention] This invention is carried out with a gestalt which was explained above, and does so effectiveness which is indicated below.

[0018] The light emitting device which carries out outgoing radiation of the transmitting light of the 1st wavelength, and the spectral separation filter which penetrates the transmitting light by which outgoing radiation is carried out from said light emitting device, The lens which condenses the light which penetrated said spectral separation filter by the end face by which the slanting cut of the optical fiber was carried out, It has the photo detector which receives the receiving light of the 2nd wavelength which outgoing radiation was carried out from the end face of said optical fiber, and was collimated by said lens. While said receiving light sets the diameter phi of said opening as $\phi=0.3f$ (however, f focal distance of said lens) in the optical transceiver module which is reflected by said spectral separation filter and results in said photo detector through opening of a diameter phi If only $d=f-\sin \theta$ (however, theta outgoing radiation angle from the optical fiber of said receiving light) carries out eccentricity of the core of said opening to the straight line given at right angles to said opening through the intersection of the medial axis of said lens, and said spectral separation filter Although the receiving light of the 2nd wavelength by which outgoing radiation was carried out from the end face of an optical fiber can carry out incidence to the light-receiving side of a photo detector through opening Since this transmitting light does not reach the light-receiving side of a photo detector through opening even if it is reflected with a spectral separation filter after a part of transmitting light of the 1st wavelength by which outgoing radiation was carried out from the light emitting device reflects by the end face of an optical fiber, The transmitting light which reaches a photo detector can be reduced and the S/N ratio of an input signal can be raised.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view of the optical transceiver module concerning one example of this invention.

[Drawing 2] It is the sectional view of the case block with which this optical transceiver module is equipped.

[Drawing 3] It is the explanatory view showing the important section of this optical transceiver module.

[Drawing 4] It is the sectional view showing the conventional optical transceiver module.

[Description of Notations]

5 Spectral Separation Filter

6 LD (Laser Diode)

9 PD (Photodiode)

13 Lens

12 Optical Fiber

20 Case Block

35 Opening

[Translation done.]

* NOTICES *

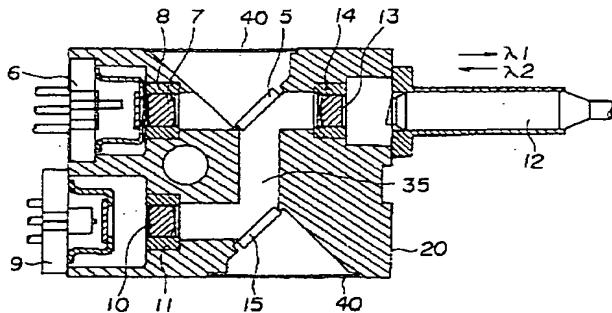
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DRAWINGS

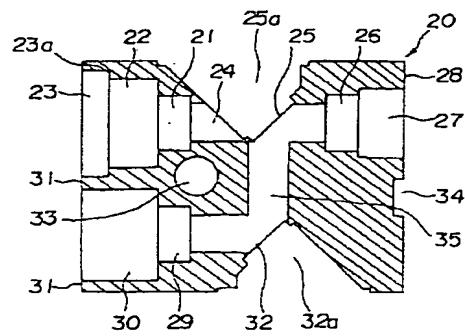
[Drawing 1]

[図 1]



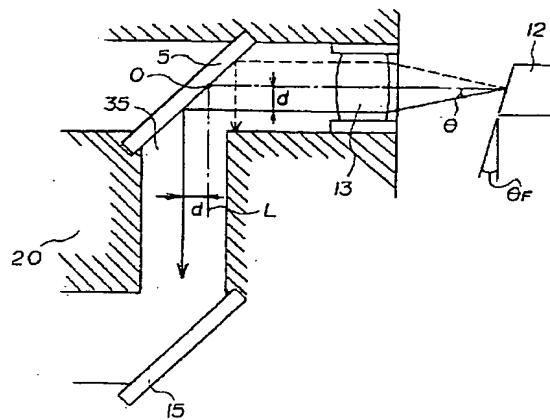
[Drawing 2]

[図 2]



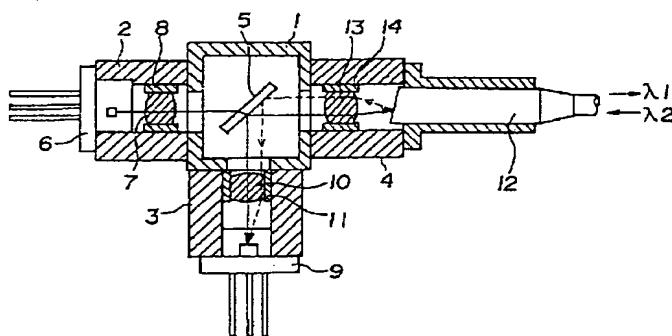
[Drawing 3]

[図 3]



[Drawing 4]

[図 4]



[Translation done.]

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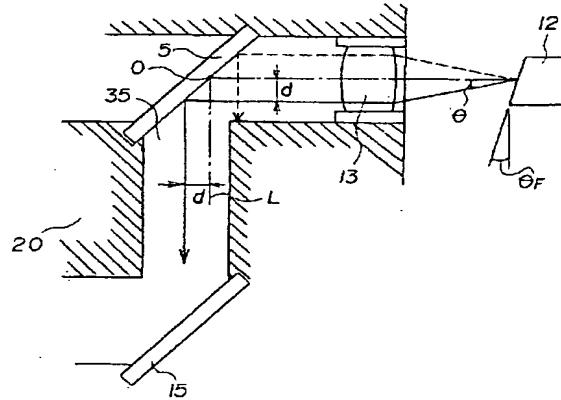
(54)【発明の名称】光送受信モジュール

(57)【要約】

【課題】発光素子から出射された送信光の一部が光ファイバの斜めカットされた端面で反射した後に分波フィルタで反射されて受光素子に達することを防止し、受信信号のS/N比を向上させること。

【解決手段】筐体ブロック20に対して第1の波長の送信光を出射するLD6と、LD6から出射される送信光を透過する分波フィルタ5と、分波フィルタ5を透過した光を光ファイバ12の斜めカットされた端面で集光するレンズ13とを同軸に取付けると共に、この光軸と平行に受光用の反射ミラー15と、第2の波長の受信光を受光するPD9とを同軸に取付ける。前記筐体ブロック20には分波フィルタ5と反射ミラー15との間を連通する開口35を形成し、この開口35の直径φを $\phi \leq 0.3f$ (ただし、fはレンズ13の焦点距離) に設定すると共に、レンズ13の中心軸と分波フィルタ5との交点Oを通って開口35に垂直に下した直線Lに対し、開口35の中心を $d = f \cdot \sin \theta$ (ただし、θは受信光の光ファイバ12からの出射角) だけ偏心させた。

【図3】



【特許請求の範囲】

【請求項1】 第1の波長の送信光を出射する発光素子と、前記発光素子から出射される送信光を透過する分波フィルタと、前記分波フィルタを透過した光を光ファイバの斜めカットされた端面で集光するレンズと、前記光ファイバの端面から出射されて前記レンズによりコリメートされた第2の波長の受信光を受光する受光素子とを備え、前記受信光が前記分波フィルタにより反射されて直径 ϕ の開口を通って前記受光素子に至る光送受信モジュールにおいて、

前記開口の直径 ϕ を

$\phi \leq 0.3f$ (ただし、 f は前記レンズの焦点距離) に設定すると共に、

前記レンズの中心軸と前記分波フィルタとの交点を通って前記開口に垂直に下した直線に対し、前記開口の中心を

$d = f \cdot \sin \theta$ (ただし、 θ は前記受信光の光ファイバからの出射角)

だけ偏心させたことを特徴とする光送受信モジュール。

【請求項2】 請求項1の記載において、前記開口の直径 ϕ を

$0.2f \leq \phi \leq 0.3f$

に設定したことを特徴とする光送受信モジュール。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、複数の異なる波長の送信光と受信光が伝送される光ファイバに対して発光素子と受光素子を結合するための光送受信モジュールに関する。

【0002】

【従来の技術】 図4は従来の光送受信モジュールの断面図であり、同図に示すように、この光送受信モジュールの筐体は、大別して中央ブロック1、LD(レーザダイオード)ブロック2、PD(フォトダイオード)ブロック3、およびファイバブロック4の4つのブロックにより構成され、中央ブロック1内には分波フィルタ5が取り付けられている。LDブロック2には、発光素子であるLD6とレンズ7を支持するレンズホルダ8とが取付けられ、PDブロック3には、受光素子であるPD9とレンズ10を支持するレンズホルダ11とが取付けられ、ファイバブロック4には、光ファイバ12とレンズ13を支持するレンズホルダ14とが取付けられている。

【0003】 LD6から出射された波長 λ_1 の送信光は、LDブロック2側のレンズ7により平行化された後、中央ブロック1内の分波フィルタ5を透過し、次いでファイバブロック4側のレンズ13により集光されて光ファイバ12の端面に入射し、光ファイバ12を介して送信される。一方、光ファイバ12を介して伝送された波長 λ_2 の受信光は、光ファイバ12の端面で拡散した後、ファイバブロック4側のレンズ13により平行化

され、次いで中央ブロック1内の分波フィルタ5により反射され、次いでPDブロック3側のレンズ10により集光され、PD9により受光される。

【0004】

【発明が解決しようとする課題】 ところで、前述した従来の光送受信モジュールにおいては、LD6から出射された波長 λ_1 の送信光が光ファイバ12の先端面で反射してLD6に戻ることを防止するために、光ファイバ12の先端面が所定の角度で斜めにカットされている。

【0005】 しかしながら、図4の破線で示すように、光ファイバ12の斜めカットされた端面で反射した波長 λ_1 の送信光の一部が、ファイバブロック4側のレンズ13を通って分波フィルタ5により反射された後、PDブロック3側のレンズ10を通ってPD9の受光面に入射することがあり、このような場合には、受信信号のS/N比が悪化するという問題があった。

【0006】

【課題を解決するための手段】 本発明は、光ファイバの端面から出射された受信光が分波フィルタで反射されて受光素子に至る光路中に、透過する光を制限できる開口を設けることとする。このような開口を設けると、光ファイバの端面から出射された第2の波長の受信光は開口を通って受光素子の受光面に入射できるが、発光素子から出射された第1の波長の送信光の一部が光ファイバの端面で反射した後に分波フィルタで反射されたとしても、この送信光は開口を通って受光素子の受光面に達しないため、受光素子に到達する送信光を低減でき、受信信号のS/N比を向上させることができる。

【0007】

【0008】 【発明の実施の形態】 本発明の光送受信モジュールでは、第1の波長の送信光を出射する発光素子と、前記発光素子から出射される送信光を透過する分波フィルタと、前記分波フィルタを透過した光を光ファイバの斜めカットされた端面で集光するレンズと、前記光ファイバの端面から出射されて前記レンズによりコリメートされた第2の波長の受信光を受光する受光素子とを備え、前記受信光が前記分波フィルタにより反射されて直径 ϕ の開口を通って前記受光素子に至る光送受信モジュールにおいて、前記開口の直径 ϕ を $\phi \leq 0.3f$ (ただし、 f は前記レンズの焦点距離) に設定すると共に、前記レンズの中心軸と前記分波フィルタとの交点を通って前記開口に垂直に下した直線に対し、前記開口の中心を $d = f \cdot \sin \theta$ (ただし、 θ は前記受信光の光ファイバからの出射角) だけ偏心させた。

【0009】 また、前記光ファイバからの入射効率のレベルダウンを考慮して、前記開口の直径 ϕ の下限を $0.2f \leq \phi \leq 0.3f$ の範囲に設定した。

【0010】

【実施例】 実施例について図面を参照して説明すると、図1は本発明の一実施例に係る光送受信モジュールの断

面図、図2は該光送受信モジュールに備えられる筐体ブロックの断面図、図3は該光送受信モジュールの要部を示す説明図であり、図4に対応する構成部材には同一の参照符号が付してある。

【0010】図1と図2に示すように、本実施例に係る光送受信モジュールは1つの筐体ブロック20を有し、この筐体ブロック20に対して従来例において説明したLD6と、レンズ7を支持するレンズホルダ8と、分波フィルタ5と、伝送路側のレンズ13を支持するレンズホルダ14と、先端面が斜めカットされた光ファイバ12とが同軸に取付けられている。また、この光軸と平行に筐体ブロック20に対して受光用の反射ミラー15と、レンズ10を支持するレンズホルダ11と、PD9とが同軸に取付けられている。なお、反射ミラー15の代わりに、波長入2の光を反射できる分波フィルタを用いても良い。

【0011】図2に詳しく示すように、筐体ブロック20には、レンズホルダ8を配置するための開口21と、LD6の本体部を配置するための開口22と、LD6のフランジ部を取付けるための取付穴23と、光路用の開口24とが連続的に形成されている。取付穴23の内底面23aはLD6の取付基準面となっており、LD6はそのフランジ部を取付穴23の内底面23aに突き合わせた状態で筐体ブロック20に溶接される。これにより、LD6はフランジ部全体が取付穴23の内部に嵌合してリード部のみが筐体ブロック20の側面31から露出する。また、筐体ブロック20には、この発光側の開口21、22、24と同軸に、分波フィルタ5を光軸に対して斜め45°に取付けるための取付面25と、レンズホルダ14を配置するための開口26と、光路用の開口27とが形成されており、光ファイバ12は筐体ブロック20の側面28に取付けられる。また、筐体ブロック20には、発光側の開口21、22、24と平行に、レンズホルダ11を配置するための開口29と、PD9の本体部を配置するための開口30と、反射ミラー15を光軸に対して斜め45°に取付けるための取付面32とが形成されている。さらに、筐体ブロック20には、両取付面25、32を連通する開口35が形成されており、この開口35は発光側の開口21、22、24と受光側の開口29、30のそれぞれに対して直交している。筐体ブロック20の側面31はPD9の取付基準面となっており、PD9はそのフランジ部を側面31に突き合わせた状態で筐体ブロック20に溶接される。これにより、PD9はフランジ部およびリード部が側面31から露出するように筐体ブロック20に取付けられ、筐体ブロック20に対してLD6はPD9よりPD9のフランジ部分だけ内側に取付けられることになる。

[0012] 分波フィルタ5の取付面25と反射ミラー15の取付面32に垂直な前方はそれぞれ大きく開放しており、これらの開放部分に対応する切欠き25a、3

2aが筐体ブロック20に形成されている。これら切欠き25a, 32aは筐体ブロック20に被着された一対のカバー40によって覆われている。なお、筐体ブロック20にはビス穴33と係台溝34が形成されており、ビス穴33は光送受信モジュールを電子機器のシャーシやプリント基板等に固定するためのビス(図示せず)の挿入用穴であり、係台溝34はビス止め時に光送受信モジュールが回転することを防止するためのものである。

【0013】上記の如く構成された光送受信モジュールにおいて、LD6から出射された波長入1の送信光は、レンズ7により平行化された後、分波フィルタ5を透過してレンズ13により集光されて光ファイバ12の端面に入射し、光ファイバ12を介して送信される。一方、光ファイバ12を介して伝送された波長入2の受信光は、光ファイバ12の端面で拡散した後、レンズ13により平行化されて分波フィルタ5により反射され、次いで反射ミラー15により反射されてレンズ10により集光され、PD9により受光される。ここで、LD6から出射された波長入1の送信光は分波フィルタ5を透過してレンズ13により集光されるが、図3の破線で示すように、その一部が光ファイバ12の端面で反射した後、レンズ13を通りて分波フィルタ5に戻るため、前記開口35の形成位置と大きさを特定することにより、かかる送信光がPD9の受光面に入射してクロストークを発生しないようにしてある。

〔0014〕すなわち、図3に詳しく示すように、レンズ13の中心軸と分波フィルタ5の交点を○とし、この交点○を通って前記開口35に垂直に下した直線をしとすると、開口35の中心は直線しに対して、

だけ偏心した位置に形成されている。この①式において、 f はレンズ 1 3 の焦点距離、 θ は光ファイバ 1 2 の端面から出射される受信光の出射角であり、光ファイバ 1 2 の斜めにカットされた先端面の角度を θ_F 、光ファイバ 1 2 のコアの屈折率を n とすると、出射角 θ は次式のとくえられる。

また、開口3.5の大きさについて検討すると、SMF（シングルモードファイバ）からの出射光は強度分布がほぼガウス分布であり、強度が $1/e^2$ となるNA（開口数）は約0.08で、光ファイバ1.2からの出射光の角度 θ に対する強度分布 I は次式(3)で表される。

$$I \equiv e^{-0.0956 \times 6} \dots \dots \dots \textcircled{3}$$

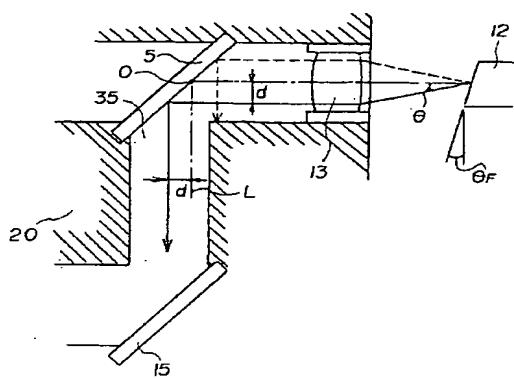
角度 θ_1 に含まれる光量 P は

$$P = 1 - e^{-0.0956 \times 6} \dots \dots \dots \textcircled{4}$$

であるから、この④式より、光量Pが99.9%（100%は無限大のため）となる時のθが $\theta = 8.627^\circ$ として求められ、 $NA = \sin \theta$ であるから $NA = 0.15$ となる。つまり、レンズ13は $NA = 0.15$ でほぼ100%の光が入ることになり、開口35の直径をゆと

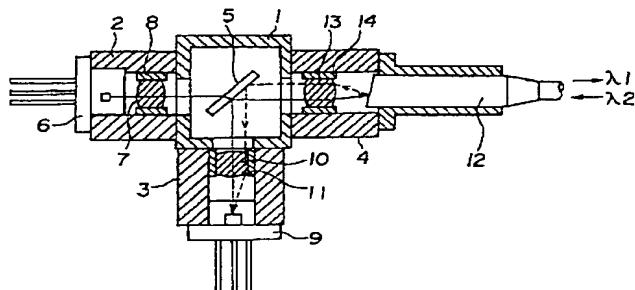
【図3】

【図3】



【図4】

【図4】



フロントページの続き

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